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Supplemental Material

TNF α and IL-6 Responses to Particulate Matter *in Vitro*: Variation According to PM Size, Season, and Polycyclic Aromatic Hydrocarbon and Soil Content

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Table S1. Descriptive statistics for PM₁₀ constituents per season, listed in descending order according to the Dry-cold season constituent percentages.

Constituent ^a	Dry-cold season			Rainy-warm season		
	Median	Mean ± SD	%	Median	Mean ± SD	%
Ca*	36,373.7	35,697.4 ± 5,468.0	52.151	89,749.3	93,481.9 ± 30,757.5	74.045
S*	18,009.7	17,754.4 ± 3,828.2	25.938	13,665.7	16,449.3 ± 10,094.9	13.029
K*	5,167.6	6,284.4 ± 2,699.7	9.181	2,081.0	2,579.2 ± 1,173.5	2.043
Na*	3,897.0	3,994.7 ± 1,204.5	5.836	5,710.4	6,853.3 ± 2,817.6	5.428
Mg	1,425.8	1,484.7 ± 310.7	2.169	1,234.0	1,372.0 ± 437.9	1.087
Si*	1,112.7	1,087.6 ± 276.4	1.589	1,731.5	1,930.3 ± 814.5	1.529
Zn	330.1	475.9 ± 378.7	0.695	334.2	538.2 ± 624.5	0.426
Fe*	463.0	452.2 ± 63.2	0.661	585.8	675.4 ± 291.9	0.535
Cu	143.6	283.3 ± 291.5	0.414	174.5	881.7 ± 1,673.3	0.698
V*	186.7	218.6 ± 95.0	0.319	127.5	146.8 ± 78.6	0.116
Al*	116.9	130.0 ± 44.6	0.190	621.4	786.1 ± 407.8	0.623
Ba	123.6	128.4 ± 44.3	0.188	112.9	142.2 ± 103.0	0.113
Mn	123.2	123.7 ± 21.8	0.181	105.8	129.4 ± 71.8	0.103
Sr*	104.9	108.3 ± 19.3	0.158	124.3	135.4 ± 49.6	0.107
Sb*	79.4	82.9 ± 32.9	0.121	26.9	29.1 ± 17.0	0.023
As*	22.8	31.9 ± 20.3	0.047	12.7	15.9 ± 11.2	0.013
Ni*	19.0	22.0 ± 9.0	0.032	12.0	17.3 ± 11.8	0.014
<i>Acenaphthylene</i>	16.6	18.8 ± 16.1	0.027	21.5	22.6 ± 8.4	0.018
<i>Fluoranthene*</i>	7.3	8.4 ± 6.2	0.012	1.6	1.6 ± 0.7	0.001
Rb*	7.1	7.3 ± 1.2	0.011	3.3	3.8 ± 1.5	0.003
<i>Benzo(g,h,i)perylene*</i>	6.9	7.5 ± 3.5	0.011	1.7	2.4 ± 1.8	0.002
Mo	6.8	7.2 ± 2.6	0.011	6.4	7.4 ± 4.0	0.006
Cr*	5.3	7.6 ± 5.7	0.011	7.7	10.5 ± 6.7	0.008
Pb*	5.5	6.8 ± 5.3	0.010	13.7	16.8 ± 10.6	0.013
endotoxins	4.6	5.2 ± 1.6	0.008	4.1	6.6 ± 5.4	0.005
<i>Benzo(b)fluoranthene</i>	4.4	5.1 ± 3.0	0.007	3.2	3.6 ± 1.4	0.003
<i>Pyrene*</i>	0.2	4.4 ± 8.7	0.006	1.9	2.2 ± 1.2	0.002
<i>Benzo(a)pyrene*</i>	2.9	3.5 ± 2.4	0.005	0.2	0.2 ± 0.1	0.000
<i>Chrysene</i>	2.7	3.3 ± 2.8	0.005	2.2	2.7 ± 1.3	0.002
Li	2.2	2.3 ± 1.8	0.003	1.9	4.4 ± 5.9	0.004
<i>Benzo(a)anthracene</i>	0.9	1.3 ± 1.4	0.002	0.5	0.6 ± 0.4	0.001
<i>Benzo(k)fluoranthene</i>	0.8	1.1 ± 1.1	0.002	1.0	1.2 ± 0.6	0.001
Total		68,450.2 ± 8,281.2	100.000		126,250.1 ± 44,758.3	100.000

^a ng/mg

* indicates significant differences between seasons by comparing same constituents ($p < 0.05$; Mann-Whitney test).

PAHs constituents in *Italics*.

Table S2. Descriptive statistics for PM_{2.5} constituents per season, listed in descending order according to the Dry-cold season constituent percentages.

Constituent ^a	Dry-cold season			Rainy-warm season		
	Median	Mean ± SD	%	Median	Mean ± SD	%
S*	21,073.5	20,610.2 ± 6,127.2	44.226	5,130.4	5,280.8 ± 2,651.0	19.071
Ca	7,616.4	10,481.2 ± 8,164.9	22.491	7,903.7	15,630.3 ± 18,048.4	56.448
K*	6,095.5	8,061.3 ± 5,386.7	17.298	743.1	840.1 ± 500.2	3.034
Na*	3,069.6	2,880.6 ± 1,197.8	6.181	4,269.9	4,273.5 ± 1,157.9	15.434
Zn*	985.3	1,299.2 ± 923.0	2.788	217.0	226.5 ± 114.3	0.818
Mg*	537.8	667.0 ± 463.8	1.431	214.8	318.9 ± 262.2	1.152
Fe*	443.2	461.1 ± 141.1	0.989	113.7	171.7 ± 161.4	0.620
Cu*	329.3	411.2 ± 251.5	0.882	149.7	197.6 ± 148.7	0.714
V*	322.2	335.2 ± 132.1	0.719	43.3	43.9 ± 26.2	0.159
Si	170.0	287.2 ± 255.5	0.616	186.3	341.1 ± 488.1	1.232
Al*	235.3	274.5 ± 161.7	0.589	92.1	183.1 ± 231.1	0.661
Ba*	120.0	186.3 ± 157.2	0.400	24.2	31.6 ± 24.9	0.114
Sb*	143.2	171.3 ± 80.0	0.368	14.4	15.2 ± 7.4	0.055
Mn*	89.8	106.8 ± 61.3	0.229	23.7	33.9 ± 27.9	0.123
Pb*	72.1	99.1 ± 83.8	0.213	12.8	18.2 ± 13.4	0.066
As*	43.0	61.8 ± 46.5	0.133	5.7	8.4 ± 8.5	0.030
Sr*	44.5	57.2 ± 39.4	0.123	10.3	21.9 ± 24.2	0.079
Ni*	42.4	44.8 ± 18.2	0.096	6.5	7.9 ± 5.4	0.029
<i>Benzo(g,h,i)perylene*</i>	15.7	16.8 ± 7.5	0.036	1.3	1.4 ± 0.9	0.005
Cr*	7.2	12.9 ± 16.4	0.028	4.3	5.6 ± 4.7	0.020
<i>Benzo(b)fluoranthene*</i>	10.1	11.4 ± 5.3	0.024	1.7	5.0 ± 7.3	0.018
<i>Fluoranthene*</i>	10.6	10.5 ± 2.7	0.022	0.7	0.9 ± 0.5	0.003
Mo*	9.7	10.3 ± 4.6	0.022	2.0	2.8 ± 2.3	0.010
<i>Benzo(a)pyrene *</i>	8.1	9.5 ± 4.6	0.020	0.1	0.1 ± 0.0	0.000
Rb*	7.1	7.4 ± 2.2	0.016	0.8	1.5 ± 2.2	0.005
<i>Acenaphthylene*</i>	0.8	6.1 ± 15.7	0.013	17.6	21.0 ± 9.8	0.076
<i>Chrysene*</i>	4.8	5.5 ± 2.8	0.012	0.7	0.9 ± 0.6	0.003
<i>Benzo(k)fluoranthene *</i>	3.6	4.4 ± 2.6	0.009	0.3	0.4 ± 0.3	0.001
<i>Benzo(a)anthracene*</i>	3.5	3.9 ± 2.1	0.008	0.2	0.2 ± 0.2	0.001
<i>Pyrene</i>	0.3	3.0 ± 5.0	0.007	0.7	0.9 ± 0.7	0.003
endotoxins*	2.1	2.3 ± 1.7	0.005	0.5	1.0 ± 1.2	0.003
Li	2.1	2.3 ± 2.7	0.005	1.4	3.4 ± 4.2	0.012
Total		46,602.4 ± 16,132.5	100.000		27,689.5 ± 21,017.9	100.000

^a ng/mg

* indicates significant differences between seasons by comparing same constituents ($p < 0.05$; Mann-Whitney test).

PAHs constituents in *Italics*.

Table S3. Constituents excluded from the statistical analysis.

Constituent ^a	PM ₁₀		PM _{2.5}	
	Dry-cold	Rainy-warm	Dry-cold	Rainy-warm
	mean ± SD	mean ± SD	mean ± SD	mean ± SD
<i>Acenaphthene</i>	2.5 ± 5.1	n/d ± --	1.96 ± 2.6	n/d ± --
<i>Anthracene</i>	3.17 ± 2.81	n/d ± --	4.21 ± 2.98	n/d ± --
<i>Dibenz(a,h)anthracene</i>	n/d ± --	0.72 ± 0.49	0.85 ± 1.13	0.27 ± 0.39
<i>Phenanthrene</i>	n/d ± --	12.05 ± 3.29	9.82 ± 14.14	3.43 ± 3.04
<i>Fluorene</i>	0.89 ± 0.9	n/d ± --	1.87 ± 5.25	n/d ± --
<i>Indeno(1,2,3-cd)pyren</i>	4.44 ± 8.85	n/d ± --	9.74 ± 7.57	n/d ± --
<i>Naftene</i>	6.3 ± 11.42	n/d ± --	9.28 ± 7.14	n/d ± --
Silver(Ag)	n/d ± --	0.23 ± 0.03	n/d ± --	n/d ± --
Beryllium(Be)	n/d ± --	n/d ± --	n/d ± --	n/d ± --
Bismuth(Bi)	n/d ± --	n/d ± --	n/d ± --	n/d ± --
Cadmium(Cd)	4.21 ± 4.68	n/d ± --	16.07 ± 11.63	n/d ± --
Cobalt(Co)	1.49 ± 0.33	1.14 ± 0.94	0.91 ± 0.4	0.7 ± 0.41
Mercury(Hg)	n/d ± --	n/d ± --	n/d ± --	n/d ± --
Scandium(Sc)	n/d ± --	0.23 ± 0.22	n/d ± --	0.13 ± 0.06
Tin(Sn)	27.39 ± 7.49	n/d ± --	58.31 ± 26.4	n/d ± --
Terbium(Tb)	n/d ± --	n/d ± --	n/d ± --	n/d ± --

^a ng/mgn/d = below detectable limits. PAHs constituents in *Italics*.

Table S4. PCA-Component Matrix.

Constituent	C ₁	C ₂	C ₃
K	.919		
V	.896		
S	.865		
<i>Benzo(a)pyrene</i>	.849		
<i>Benzo(a)anthracene</i>	.844		
<i>Fluoranthene</i>	.838		
<i>Chrysene</i>	.834		
<i>Benzo(k)fluoranthene</i>	.833		
<i>Benzo(g,h,i)perylene</i>	.786		
Fe	.727		
Zn	.694		
<i>Benzo(b)fluoranthene</i>	.606		
Ca		.935	
Mg		.762	
endotoxins		.719	
Si		.646	
Al		.646	
Na		.637	
<i>Pyrene</i>			.621
<i>Acenaphthylene</i>			.501

Loadings for the three principal components extracted (C₁, C₂, C₃). Values below 0.5 were not shown to highlight the strength of the relationships between constituents and specific principal components. PAHs constituents in *Italics*

Table S5. Regression model for TNF α production (ln-transformed) and the percentage of C₁-related PAHs, adjusted by PM-size and C₁ + C₂ content (quartiles).

ln-TNF α	Estimated coefficients	t	P>t	95% CI
C ₁ -related PAHs (%)	-8.21	-6.68	0.000	(-10.66, -5.77)
PM-size	1.02	4.29	0.000	(0.55, 1.49)
C ₁ +C ₂ mass quartile 2	0.41	1.91	0.059	(-0.02, 0.85)
C ₁ +C ₂ mass quartile 3	0.60	2.16	0.034	(0.05, 1.16)
C ₁ +C ₂ mass quartile 4	0.89	3.01	0.004	(0.30, 1.48)
const.	2.83	14.54	0	(2.45, 3.22)

n=90; F (5,84)=53.46; Prob>F=0; R-squared=0.76; Adj R-squared=0.7; Root MSE=0.70; C₁+ C₂ mass quartile 1 is the reference for quartile adjustment. According to this model an increase of one-unit in C₁-related PAHs would result in $(e^{-8.21} - 1) * 100$ percentage change in TNF α production.

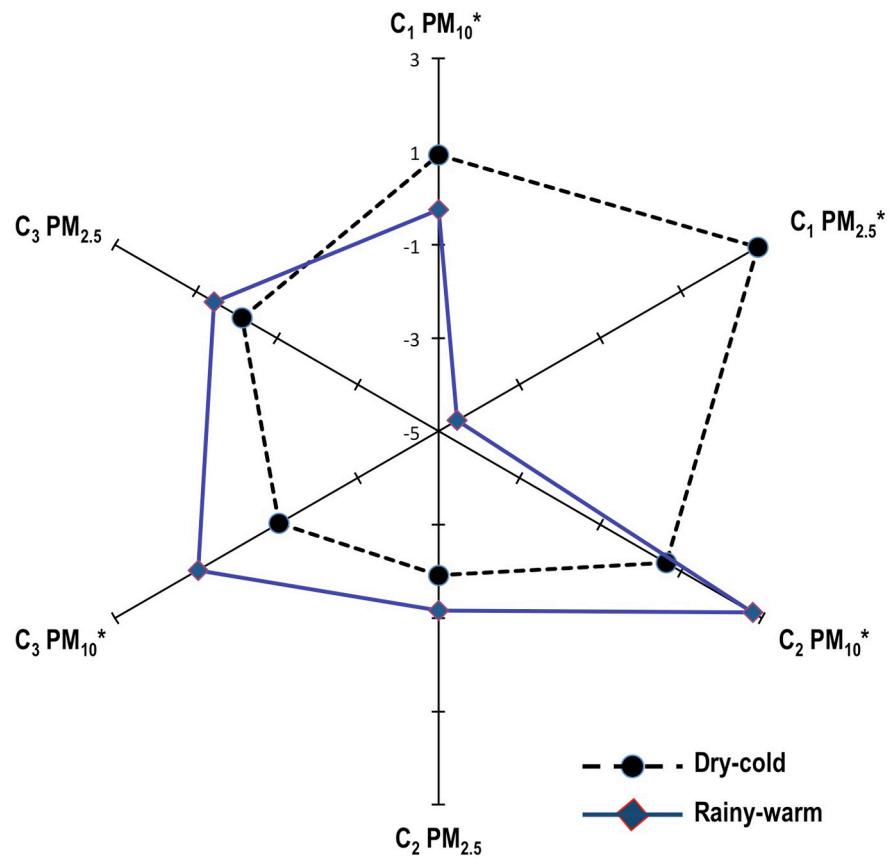


Figure S1. Radial plot of the C_1 , C_2 and C_3 component scores, according to PM-size and season. In PM_{10} , the averages were different between seasons ($p<0.05$), whereas in $\text{PM}_{2.5}$ exclusively C_1 was different between seasons. (*) Indicates significant differences between seasons by PM-size ($p<0.05$).